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THE TARBAGAN (*ARCTOMYS BOBAC*) AND PLAGUE.

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There seems to be considerable evidence that the tarbagan, *Arctomys bobac*, has been for many years associated with outbreaks of plague in Siberia, Mongolia, and Manchuria. This association has been mentioned in the writings of numerous Russian and other investigators and many hypotheses have been set forth. But, so far as the writer has been able to determine, no authentic proof has been forthcoming that the disease from which the tarbagan suffers and which is apparently transmissible to man, is true plague. Most of the statements concerning the disease heretofore have been quoted from the natives of the localities where this marmot lives, and until quite recently no writer has seen or described, after personal investigation, the disease in the tarbagan. And further there seem to be no positive or authoritative statements which fix the status of the tarbagan disease on a bacteriological or pathological basis.

THE TARBAGAN (*ARCTOMYS BOBAC*).

The tarbagan has been called by various authors sarbagan, sara-bagan, tarabagan, phutiya, and han ta. The spelling, tarbagan, is that given by the Russian writers, who believe it to be of Transbaikalian origin, and who have observed on the spot the disease to which this animal is subject.

The tarbagan is said to be indigenous to Thibet and common in Mongolia. At least six species of *Arctomyinæ*, the subfamily to which the tarbagan is said to belong, are reported to be found in various parts of Central Asia, but the so-called tarbagan appears to be the most widely spread. In Europe it is found as far west as Russia and eastern Germany. In Asia its habitat is given as Siberia, Mongolia, Thibet, and Manchuria.

According to Tchaouchov this animal is a hibernating rodent of the genus *Marmota* (synonym, *Arctomys*; subfamily, *Arctomyinæ*) and is classified as *Arctomys bobac*. There are many species of *Arctomyinæ* and Blue (1) notes 12 varieties for California. The American ground hog, woodchuck, and ground squirrel belong to this same family.

In the new National Museum there are specimens of an animal classed as *Marmota bobac*. This animal has rather long, coarse, yellow,

and light-brown fur, the tips of the hairs being dark. All the specimens are somewhat larger than the tarbagan as described below by Tchaouchov. Mr. G. S. Miller, curator of mammals at the museum, believes that the quality of the fur of these specimens argues against the statement that this species could be used to imitate to any large extent the fine fur of martin and sable. He states that our knowledge of the fauna of the region where the tarbagan is said to be found is far from complete and that it seems to him very probable that there is more than one species of rodentia included among the so-called tarbagans.

Pallas (2) in 1778 classified the tarbagan as *Marmota bobac*. Skschivan (19) and others refer to the tarbagan as *Arctomys bobac*. There seems but little doubt that the animal properly known as the tarbagan is this species.

The fur of the larger spermophiles known to inhabit Mongolia and northern Manchuria would lend itself more easily to the imitation of sable or martin, as it is of a finer quality. It may be that the so-called "tarbagan hunters" in reality trap several varieties of marmots and spermophiles, and it seems very possible that it may, at some future date, be determined definitely that the spermophiles of Mongolia, Manchuria, and Siberia are also instrumental in spreading plague. But until the fauna of these regions has been more accurately established and until more definite bacteriological and pathological evidence is advanced establishing the susceptibility of these rodents to plague it seems impossible to determine whether the *bobac* alone is responsible for the reported outbreaks of plague or whether other rodents may not harbor the bacillus of plague and transmit it to man.

Tchaouchov (3) describes the tarbagan as a little larger than a rabbit: 37 centimeters long, with a tail 9 centimeters; weight, from 6 to 8 kilograms; paws, short and heavy; the hind legs, larger and provided with stout claws for digging and for defense and attack; the upper lip, fleshy and bifurcated; the incisors, covered with steel-like enamel.

The animal lives in burrows extending 2 meters below the surface of the ground, with a passage 10 to 14 meters long leading into a nest or chamber 1 to 2 meters in diameter, the floor of which is covered with dried grass. The main burrow has several secondary passages for ventilation and exit. The tarbagan is found usually in large colonies, occupying a space several square kilometers in area and recognizable by the hummocks at the mouths of the burrows. They feed on herbs and roots, and in captivity will eat roots, cabbages, and similar foods, and will take milk readily.

With the beginning of October they shut themselves in their burrows to hibernate until March or April, filling the entrances to their burrows with dirt, stones, and grass. From time to time they awaken to get rid of accumulated feces, which they utilize to fill the cracks in their nests, but from December on they fall into a sort of catalepsy. At the beginning of spring they are lean from the lack of nourishment, and at this time the females bear from 4 to 6 young. The tarbagan in health utters a cry which sounds like "*pu p'a*," and which, according to the Chinese, means "no harm."

Tarbagans are hunted now principally for their fur, which is in considerable demand, and is used to imitate martin and sable. Use is also made to some extent by the natives of their flesh which is said

to have the flavor of goose, and of their fat for greasing leathers and for lighting. One tarbagan will yield at least 2 kilograms of oil, the price of which varies between 10 and 30 cents in Siberia. This oil is very penetrating, and does not harden in the coldest weather. The fur is generally sold at a price of from 5 to 15 kopecks (2 to 7 cents). It is reported that from a single region (Kobdo-Oulaseutai) a half million skins are brought annually to the market place at Irbit.

PLAGUE IN TARBAGANS.

Tchaoushov (3) states that, according to Skschivan, the most ancient Thibetan writings describe a disease of tarbagans which was considered to be highly contagious and caused by worms found in the roots of certain plants, and which was transmitted to man; also that Tcherkashov first pointed out in 1867 that a large number of tarbagans died in certain years from a contagious disease, and that the natives who ate the flesh of these animals during the epizootic died, but he gives no details.

In 1892 there appeared a short article in a Transbaikal journal (4) in the form of an official warning from the authorities to the inhabitants against the dangers of the disease.

Biéliavski and Riëshetnikoff (5) in 1895 gave probably the best account of the disease in tarbagans published up to that time. They called it "tarabagania tchuma"; that is, plague (tchuma) arising in connection with the "tarabagania." Twenty-six cases were collected in the Akshin military district among six families between 1888 and 1894, and in addition they report six bodies of "Buriats" who were said to have died from this disease of tarbagans. That the six died from plague seems evident from the fact that a physician and his assistant who made necropsies on the bodies died from a disease which was proven to have been plague.

Biéliavski states that periodically the tarbagans are attacked by an epizootic, usually beginning in the autumn just before the hibernating season. According to him, the disease is highly contagious and is spread to man by eating the flesh of the animal, but more easily by simple contact with sick tarbagans. He visited the village of Sektui after an outbreak in a Cossack family in 1894. The first case, a male, in this family was traced to the tarbagan. The natives are well informed of the existence of the disease among the tarbagans and during epizootics refrain from touching the sick animals.

Riëshetnikoff was of the opinion that the epizootic in this rodent usually breaks out in years of great drought, when the animal is forced to go without food and water, and that the disease spreads to man by contact.

Podbielski (6) believed that tarbagans became infected by feeding on grass which had been contaminated by bodies of hunters and native nomads who had died from plague and who had been left by their companions and were later devoured by wild animals. He was also of the opinion that in Mongolia there are certain permanent plague foci in the ground from which tarbagans become infected.

Tchaoushov (3) states that he is of the opinion that the disease appears first in man and then spreads to the rats and tarbagans, both of which subsequently may be the cause of the disease in man (by fleas and by contact with dead tarbagans). He believes the

disease, which he is convinced is plague, is less dangerous for man than rat plague, because ordinarily man is not associated with tarbagans in the same manner that he is with rats. Tarbagans affected with this disease have nearly all died by the approach of winter, and only the healthy ones hibernate. It might be supposed that the sick animals, at the approach of winter, would hide in the empty summer burrows and die there, and that from these burrows in the spring a fresh outbreak of the epizootic might occur. But according to Skschivan (7) and others, the disease makes its appearance only at the end of summer and the beginning of autumn, when the tarbagans, on account of thirst and hunger, devour the human plague cadavers left on the ground.

Skschivan (7) has observed that the disease manifests itself usually during the autumn in many different localities near endemic foci, and that the disease is readily conveyed to man, in whom are observed all the usual signs of plague.

Schreiber (8), according to Tchaoushov (2), believed that the disease in tarbagans was true plague, identical with plague in man, but that the disease was not peculiar to this species as glanders is peculiar to horses. Schreiber (9) was sent by the Russian Government at the end of 1905 into the infected region in Mongolia for a scientific investigation of the disease. In his paper he stated that he had been unable to observe the disease either in man or the tarbagan, apparently on account of the fact that the disease breaks out only in the autumn and that he arrived in the region too late to find cases. His reports of outbreaks, obtained from the natives, are similar to those of other writers. In a summary he gave certain reasons which seemed to him to militate against the identity of the disease in the tarbagan with true plague in man: (1) The undoubted occurrence of these epizootics without human beings being infected. (2) The fact that field mice, which are known to be susceptible to plague, do not contract the tarbagan disease. (3) The fact that domestic animals escape it.

Kokossoff, according to Tchaoushov (3), is the only physician who has observed sick tarbagans; but he speaks only of the loss of the instinct of self-preservation, in addition to the symptoms mentioned by other writers.

Clemow (10), in 1900, in a paper on plague in the lower animals, called attention to the infection of the tarbagan with a disease supposed by many writers to be plague and also summarized the article by Biéliavski and Riéshetnikoff. He believed that it was not possible to be certain of the nature of the disease in tarbagans, but that it could only be asserted that there was (1900) in Transbaikalia, near the Mongolian frontier, a center of endemic disease which, if not identical with plague, had many points in common with it and that the most important respect in which the disease appeared to differ from plague was in the absence of marked mental symptoms. The description of the pulmonary symptoms resembles to a considerable extent that of the symptoms of plague pneumonia. He also stated that there is a center of undoubted plague in eastern Mongolia and that it is said to be associated with the tarbagan.

While there seems to be sufficient evidence to associate the tarbagan directly with outbreaks of plague in Siberia, Matignon (11) and Zabolotny (12), who were sent into Mongolia to study the outbreaks that

had been occurring there since 1888, reported that they found no evidence of mortality among rats or domestic animals. Matignon, however, mentions the interesting fact that, for a number of years, the "Belgium fathers" had observed a disease in the tarbagans; but neither Matignon nor Zabolotny appear to have seen this disease. Up to 1900 there seems to be no evidence as to the identity of the disease in man and the marmot in the Mongolian center, or of its transmission from one to the other.

In 1896 there occurred in Mongolia a particularly severe epidemic. The symptoms reported were those of plague. The majority of those affected had buboes and Zabolotny obtained cultures from some of the cases, which cultures were later demonstrated to contain virulent plague organisms.

From the symptoms of the disease in Siberia and Mongolia as reported by several writers, and from the fact that Zabolotny recovered the bacillus of plague from patients in Mongolia dying from a disease giving the same symptoms found in cases in Siberia, it would seem probable that both regions suffer from what is undoubtedly true plague. And, further, considering the fact that the tarbagan is common throughout these regions and is quite definitely associated with the disease in man in Siberia, it seems also very probable that this animal plays an equally important rôle in Mongolia.

Tchaoushov (3), in a recent article, reaches the following conclusions regarding the presence of plague in the tarbagan: "(1) The tarbagan is the marmot of Asia, which is distinguishable in no way from that of Europe. (2) Plague in tarbagans is proven only in Asia and especially near certain plague centers. Plague in tarbagans has never been proven in Kamchatka and Altai. (3) Tarbagans, in case of necessity, eat meat and are able without doubt to devour human plague cadavers left on the ground, and, as a consequence, to become infected with plague. (4) Plague does not appear spontaneously among tarbagans. They become infected with plague by the intermediation of human cadavers, and are able then to give plague to man when he hunts them. (5) The mortality among tarbagans is due to various causes. Besides plague, it suffers from other contagious diseases, without speaking of the mortality due to famine. (6) In devouring plague cadavers tarbagans become infected by way of the external mucous membranes and cutaneous lesions. (7) The natives and Transbaikal Cossacks become infected with plague in removing the skins from tarbagans when a friction with infectious material takes place, and also by the intermediation of fleas from tarbagans. With the mucous membranes of the digestive tract intact it is difficult to admit the possibility of infection by meat. (8) It is necessary to admit that in the Transbaikal Province there exists or has existed an endemic plague center similar to that which exists in the government of Astrakhan."

PLAGUE IN MANCHURIA, 1910-11, AND THE TARBAGAN.

The severe outbreak of plague in Manchuria during the winter of 1910-11 has been stated to have originated among tarbagan hunters in eastern Mongolia and northwestern Manchuria (13) (14). Zabolotny seems of the opinion that rodents played no part in the spread of the disease. The prevalent type was pneumonic of a most viru-

lent nature, and spread from man to man by direct contact. Many rats were examined bacteriologically, but not one was found infected.

The native Mongols and "Buriats" are said to be well acquainted with the dangers of handling sick tarbagans, which for years have been supposed to suffer from a disease transmissible to man. The Chinese coolies from Manchuria and northern China are brought into eastern Mongolia and northwestern Manchuria to trap the tarbagans for their fur. These coolies as a rule are unable to recognize sick tarbagans and have no knowledge of the dangers in handling sick animals and so take no precautions. It is said that at least 96,000 Chinese went into Manchuria in the autumn of 1910 to trap tarbagans and to work on the farms, most of them returning to their homes in October, at which time the tarbagan begins to hibernate.

Evidence points to the fact that plague originated among coolies who handled tarbagans, which, during the autumn of 1910, were reported to have suffered from some sort of epizootic. The pneumonic form of the disease is quite common among the tarbagan hunters. The symptoms of the disease in this and other epidemics of plague bear a striking resemblance to that of the symptoms of the disease described by Biéliavski and other writers, among the natives of Siberia and Mongolia, and supposed by many to be plague and to be contracted from tarbagas.

SYMPTOMS OF THE DISEASE OF TARBAGANS.

There are numerous descriptions given of this disease of tarbagans scattered in the literature, many by Russian writers, and they are all quite similar in most details. The following is a summary from the description of Ch'uan (15), Biéliavski (5), and others:

The infected animals cease their barking, become languid, and their movements slow and unsteady. If they leave their burrows, they are unable to get back to them and thus fall a prey to their natural enemies, wolves, dogs, and eagles. If the sick do find their way back to their burrows, the healthy ones refuse them admission, and they soon die outside. Ch'uan states that they become deaf, their eyes red, and partially blind. Their paws become bloodless. The native hunters are able to determine the presence of the disease by making incisions in the paws of freshly killed tarbagans. If these bleed, the animal is healthy, but if diseased they find only coagulated blood, which finding they believe is positive evidence of the disease.

In a majority of the diseased tarbagans, a tense reddish swelling is found under the shoulder. This may be very small and indeed absent. If absent, the natives rely upon the blood clot in the paw.

Wolves seem fond of the flesh of the diseased tarbagans, but neither they nor dogs, who also devour dead tarbagans, appear to contract the disease.

SYMPTOMS OF THE TARBAGAN DISEASE IN MAN.

There seems to be sufficient evidence that the natives of Siberia, Mongolia, and neighboring countries in which the tarbagan is found suffer at certain periods from a contagious and highly fatal disease, which is contracted directly from this marmot either by handling naturally infected animals or in some instances by eating the flesh of animals that have the disease. The disease in man was referred to as "tarbagania chuma" by Rudenko (16), who is said to have discovered

it among the tarbagan hunters. Many Russian writers have described localized epidemics in tarbagan hunters and members of native tribes, and mention is often made that plague is endemic in these regions. Their description of the symptoms in these outbreaks seems to justify calling the disease plague.

Kokosoff (17) reported 11 fatal cases with the following symptoms: The members of the family in which the disease originated had all been engaged in skinning tarbagans. The symptoms in all were identical; severe headache, then a rise in temperature to about 41.6 C., followed by inflammation of the lymphatic glands in the axilla, and in some the submaxillary glands. Vomiting and diarrhea before death were noted. The illness lasted from four to seven days and was fatal in all his cases.

Riéshtnikoff (5) gave the period of incubation as four or five days. He noted the usual symptoms observed by other writers, and added pains in the thorax, accompanied by a dry cough and a disagreeable expectoration, sometimes tinged with blood. Respiration and pulse rate were increased and later weakened.

This disease in man is commonly pneumonic in character, and the tarbagans are said to suffer from a similar type of disease.

EXPERIMENTAL PLAGUE IN TARBAGANS.

At the appearance of plague in a Russian village near the Dalai Nor station, in Manchuria, in 1905, Tchaoushov (3) made some laboratory experiments with nine healthy tarbagans. They were divided into four series. The first series received an injection of fluid from a human plague bubo; the second, an emulsion of sputum containing a considerable number of the *cocco bacillus* of plague; the third, some bouillon culture; and the fourth, two tarbagans, were put into a cage with infected tarbagans. He summarized the results of his experiments as follows:

(1) Tarbagans are susceptible of being infected with the *Bacillus pestis* by the common methods used in other laboratory animals, guinea pigs, rats, mice, rabbits, and monkeys. (The friction method was not tried.)

(2) Tarbagans can be infected by the way of the nasal and ocular mucous membranes.

(3) It was not possible to determine the mode of the infection of the two tarbagans living in a cage with infected tarbagans; whether by fleas, which conveyed the virus from the infected, or to the fact that they devoured the bodies of the infected animals. One undoubtedly died of plague and the other had plague, but recovered.

(4) The pathological lesions in the tarbagans affected with plague could not be distinguished from those described in other laboratory animals.

(5) The caged tarbagans ate meat, as the natives had affirmed for a long time. He states that there is no doubt that tarbagans at large will eat meat (human cadavers) when vegetable food fails them, and that the discovery by Podbielski of human bones in and around tarbagan burrows proves it completely.

Shibayama (18) reports that experimentally the tarbagan is not so susceptible to plague as the rat. He gave a tarbagan a subcutaneous injection of one one-hundredth part of a loopful of a pneumonic strain from the recent Manchurian epidemic. The animal died several days later. Few alterations were found in the internal organs.

Skschivan (19) stated that the virulence of an organism plays an important rôle in inoculation experiments. He used an old culture of a plague organism that had so lost its virulence that by injecting one to two agar cultures into the abdominal cavity of a

guinea pig a chronic form of plague was produced with a wasting and a thickening of the great omentum. He failed to infect guinea pigs by rubbing this same culture into the shaved abdominal wall after the method of Albrecht and Ghon. He then repeated the same experiments with this nonvirulent culture in a "tarbagan (*Arctomys bobac*)" brought to him from Mongolia. By rubbing it into the shaved skin he produced a slight infection, and a subsequent subcutaneous inoculation caused a general septicæmia with a hemorrhagic plague pneumonia, but without local reaction or bubo formation.

BACTERIOLOGY OF THE DISEASE OF TARBAGANS.

From the data at hand there appears to be no positive bacteriological proof that the disease which at times becomes epizootic among tarbagans is true plague. Inspired perhaps by the recent epidemic in Manchuria and China, a scientific mission was organized, according to a recent article (20), by the Pasteur Institute in May, 1911, with the object of studying the origin of plague in the Kirghiz Steppes. No other report of their findings has appeared in the literature to the writer's knowledge, but it is to be hoped that they have been able to definitely establish the rôle played by the tarbagan in the propagation and spread of plague in these regions.

Kitasato (21) at the International Plague Conference at Mukden in April, 1911, agreed with others that the responsibility of the tarbagan must be discussed as a fact not yet bacteriologically proven. However, there appear in the literature several references (22) to the fact that bacilli presenting all the characteristics of *bacillus pestis* have been found in this marmot and also in the bodies of natives who have died from a disease contracted by handling sick tarbagans or by eating their flesh. No details of such findings have been found after rather an extensive search of the literature.

FLEAS ON TARBAGANS.

On account of the rôle played by fleas on rats and ground squirrels in the spread of plague it will be interesting to definitely determine if tarbagans harbor these parasites and if fleas are responsible for the spread of the disease among these rodents and its transmission to man. The existence of some such agent might be predicted, as plague is reported to exist in certain places in Siberia and Mongolia in endemic form both among animals and man.

Petrie (23), of the Lister Institute, a British delegate to the International Conference at Mukden in April, 1911, reports having examined 12 tarbagans sent direct from Manchuria to Mukden. Thirty-five fleas were found, with an average of 3 per animal, 12 being found on one. April was considered the season of least prevalence of fleas, and his findings suggest that tarbagans, during the flea-breeding season, are infested with fleas. The fleas found were unusually large, and appeared to resemble the flea belonging to the genus *hystrihopssylla*.

Tuck (24) suggests the flea as an intermediate host and states that there seems to be no great mortality among tarbagan hunters while in the field, but that the disease spreads rapidly when these hunters return to the market places in winter and crowd into insanitary dwellings.

SUMMARY.

Plague is known to be endemic in several regions in Siberia and Mongolia. From remote times, the tarbagan, a marmot common in these regions, has been observed to suffer from a fatal epizootic, beginning in the autumn before the hibernating season. The symptoms of this disease suggest plague. The tarbagan is hunted in the late autumn for its fur. Plague is reported to break out among hunters of tarbagans, especially among imported coolies, who, unlike the natives, are unable to detect sick animals.

Tarbagans are reported to be susceptible to inoculations with the *bacillus pestis*, and fleas have been found on them. A priori, from the rôle played by ground squirrels and their fleas in the transmission of plague, the hypothesis that a similar rôle is performed by the tarbagan is presented. This has, however, only the value of an hypothesis since bacteriological and pathological proofs are as yet lacking.

REFERENCES.

- (1) Blue, Rupert.—The Natural Habitat of Plague. Pub. Health Bul., No. 30, p. 151, U. S. Pub. Health and Mar.-Hosp. Serv., Govt. Printing Office, 1910.
- (2) Pallas, P. S.—“*Novae species quadrupedum e glirium ordine.*” Elangen, Ger., 1778.
- (3) Tchaoushov.—Bul. de l'Of. Int. d'Hyg. Pub., Par., Sept., 1911.
- (4) Zabaikalski Oblastnui Viesznik, 1892.
- (5) Biéliavski and Riéshetnikoff.—Viestnik Obshtchestvenno Gigeniui Sudeb i Prak. Med., April, 1895. Summary by Clemow. J. Trop. Med., February, 1905, and N. Y. Med. J., Aug. 31, 1895, lxii, 286.
- (6) Podbielski.—Kazan M. J., 1901, i, 297 and 312.
- (7) Skschivan.—Russk. arch. patol. klin. med. i bakteriolo., S. Peterb., 1901, xi, 603.
- (8) Schreiber.—Russk. Vrach, St. Peterb., 1907, vi, 289.
- (9) Schreiber.—Lancet, Lond., 1907, clxxiii, Dec. 7, 1907.
- (10) Clemow.—Remarks on Plague in Lower Animals. Brit. M. J., May 12, 1900. 1141-1146. Also Plague in Siberia and Mongolia and the Tarbagan (*arctomys bobac*). J. Trop. M., February, 1900.
- (11) Matignon.—Un nouveau foyer de peste bubonique. J. de Méd. de Bordeaux, 1897, xxvii, 553. Ibid, 1898, xxviii, 217. Also La Peste bubonique en Mongolie. Ann. de hyg., Par., 1898, 3. s., xxxix 227-256.
- (12) Zabolotny.—La peste en Mongolie orientale. Ann. de l'Inst. Pasteur, Par., 1899, xiii, 833-840.
- (13) Low, R. B.—Progress and diffusion of plague during 1910. 40th An. Rep. Loc. Gov't Bd., 1910-1911. Suppl.
- (14) Simond, P. L.—The epidemic in Manchuria in 1910-11, and our knowledge touching the transmission of pneumonic plague. Rev. d'Hyg. et de Pol. Sanit., No. 7, 1911; also abs. in Bull. de l'Off. Int. d'Hyg., Par., Sept., 1911, 1633.
- (15) Ch'uan.—Address. Int. Plague Conf., Mukden, Apr., 1911. Lancet, May 13, 1911.
- (16) Rudenko, A. M.—Tarbaganya chuma. Vet. feldsher., S. Peterb., 1900, iv. 298-305; also Voenno-med. J., St. Peterb., 1900, lxxviii, Med-spec. Pt., 3567.
- (17) Besser.—Notes on tarbagan plague in man observed in Mongolia and Transbaikial during 1888-1897. Voenno-med. J., S. Petrb., 1906, ccxv, 279-293.
- (18) Shibayama.—Experimental plague in tarbagans. Lancet, Lond., May 13, 1911.
- (19) Skschivan.—Centralb. f. Bakt. etc. 1. Abt., Jena, 1902-3, Bd. xxxiii, Originale, p. 269.
- (20) Prof. Metchnikoff's Mission to Siberia to Study Plague. Amer. Med., Nov., 1911, p. 587-593.
- (21) Kitasato.—Lancet, May 13, 1911.
- (22) Lancet, April 29, 1911, p. 1144. Ibid. May 13, 1911, p. 1309.
- (23) Petrie.—Fleas on tarbagans. Lancet, May 20, 1911, p. 1383.
- (24) Tuck, G. L. (Wu Sien-Teh). Lancet, Lond., April 29, 1911, p. 1117.